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XXXI. *Of the difference of longitudes found by chronometer, and by correspondent eclipses of the satellites of Jupiter ; with some supplementary information relative to Madras, Bombay, and Canton ; as also the latitude and longitude of Point de Galle and the Friar's Hood.* By J. GOLDINGHAM, Esq. F. R. S.

Read June 27, 1822.

*Of the difference of longitude found by chronometer, and by correspondent eclipses of the satellites of Jupiter.*

IN my former Paper, I mentioned these methods of finding the longitude, after the distance of one point from a first and distant meridian had been correctly established, and at the same time carried both into practice ; the former, in deducing the longitude of Bombay, and the latter, in the operation for the longitude of Calcutta ; and I bring forward the following observations by these methods, to show what may be effected in practice by either, where the instruments are good, and the necessary precautions have been taken. The observations at Masulipatam were taken by the late Mr. TOPPING, those at the Observatory, by myself. The telescopes at both places were the same in construction and magnifying power.\*

\* Masulipatam is not two days sail from Madras in the S. W. monsoon.

*Madras Observatory and Masulipatam Flag Staff.*

By correspondent eclipses of the satellites of Jupiter.

	Satellites.	Em. or Im.	D. Long to Masulipatam Flag Staff.
1794	1	E	0° 52' 6"
	1	E	0 48 22,5
1795	2	I	1 0 40,7
	1	I	1 3 0,7
	1	I	0 50 5,2
	2	I	0 46 53,2
	1	I	0 50 45,7
	1	E	0 57 23,2
	2	E	0 59 38,2
	1	E	0
	1	E	0 57 17,2
	1	E	0 54 41,2
	2	E	1 1 33,7
Mean	.	.	0 55 12
Observatory	.	.	80 17 21

Masulipatam Flag Staff 81 12 33

By Chronometer.

	Difference of Meridians.
By the chronometers of ARNOLD's, in the year 1793	0° 55' 43"
In the year 1794, by 2 chronometers of ARNOLD's	0 55 60
In the year 1795, by 1 chronometer of ARNOLD's	0 53 54
Mean	0 54 54
Observatory	80 17 21

Longitude of Masulipatam Flag Staff by chrono-	
meter . . . . .	81° 12' 15"
Longitude of Masulipatam Flag Staff by the	
eclipses . . . . .	81 12 33
By the chronometer . . . . .	81 12 15
	<hr/>
Mean	81 12 24 E
	<hr/>

Here we find a wonderful agreement by the two methods; and the longitude of *Masulipatam*, a point of importance on the coast, may be considered correctly determined.

The following information may be deemed supplementary to that given in my former paper on the Geographical situation of the three Presidencies, and it is hoped will be found useful to navigators.

At Madras, the Fort Flag Staff is about 1",6 north, and 2 east of the Church Steeple. This gives for the latitude of the Flag Staff 13° 4' 47" north, and longitude 80° 19' 44" E. As navigators generally take their departure from the Flag Staff, I have deemed it proper to give its situation, as well as that of the Steeple, given in the former paper.

The tide on the coast about Madras seldom rises more than 3 feet; and it is high water on the Syzigies, by my observations, at 9<sup>h</sup> 25<sup>m</sup>. The variation of the compass towards the end of 1792, on the coast, about a degree to the northward of Madras, was 1° 3' east, by numerous observations.

At Bombay, the time of high water on the Syzigies, at the Dock Head, from several observations which I made, was 11<sup>h</sup> 32<sup>m</sup>. The pilots generally allow 11<sup>h</sup>  $\frac{1}{2}$  as the time. The greatest rise of the tide at the Dock Head was 18 feet. This

happened at the springs near the vernal equinox of 1791 ; and except from particular combinations, it is never known to rise higher : as I was informed, the medium rise of the springs is about  $15\frac{1}{2}$  feet. The variation of the compass in the beginning of the year 1791, by the mean of many observations, I found to be  $42' 59''$ , or  $43'$  west.

During the passage from Bombay to Madras, I had an opportunity of ascertaining the latitude and longitude of Point de Galle, and of the Friar's Hood ; and as the chronometer performed so well, it is to be regretted we did not see other places on the way. Point de Galle is, however, an important position to have accurately determined, and in the year 1791, the longitude deduced from different observations varied from  $80^{\circ} 1' 30''$  to  $80^{\circ} 22'$ .

On the 8th of September we saw Point de Galle Flag Staff. Three bearings of it were taken with the azimuth compass ; one when it was  $E. 8^{\circ} 24' N.$  ; a second when it was  $N. 28^{\circ} 38' E.$  ; and the third when it was due north. The time when each bearing was taken was correctly noted ; and a base, measured by the run of the ship, corrected for current, was used for finding the distances, which, at the time the first bearing was taken, was 5.5 miles, and at the time the second was taken 3.7. The ship being in the longitude of Point de Galle at the time the third bearing was taken, no distance was necessary. Altitudes for finding the longitude by the chronometer were observed about half an hour before the first bearing was taken, which was at  $5^h 45'$  p. m. apparent time. These altitudes give for the longitude of the ship at  $5^h 10'$  p. m., (by mean of two days observations after my arrival at Madras, and allowing  $80^{\circ} 19' 42''$  as the longitude of the

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Church)  $80^{\circ} 9' 6''$ , the latitude of the ship being at that time  $6^{\circ} 2' 4''$  N. ; the difference of latitude and difference of longitude made by the ship to the times the bearings were taken, being of latitude  $2' 4''$  S. and  $4' 25''$  S. ; of longitude  $2' 27''$  E.  $6' 6''$  E. and  $8' 3''$  E.

The latitude and longitude of Point de Galle Flag Staff from these observations were

	Latitude.	Longitude.
By the first bearing	$6^{\circ} 0' 47''$ N.	$80^{\circ} 16' 59''$
Second .	6 0 58	80 16 57
Third .	. . .	80 17 9*
	<hr/> 6 0 50 <hr/>	<hr/> 80 17 2 E. <hr/>

Three bearings of the Friar's Hood were also taken on the 10th of September with an azimuth compass : one when we were nearly in the latitude, and another when in the longitude of the Hood. The same care was taken in finding the distances, &c. ; and the latitude of the Hood was found to be  $7^{\circ} 29' 35''$  N. ; longitude  $81^{\circ} 36' 3'' \frac{1}{4}$  E.

It will no doubt be concluded, that where so much attention was paid to have the correct bearings and distances, that the meridional observation for the latitude, and the altitudes for the longitude, were taken with a sextant :—this was the case ; and two sets of the latter were always observed.

About the time the earliest of the observations mentioned in my former paper were taken, three correspondent eclipses of the satellites of Jupiter had been observed at Canton, by

\* By the late authorities, Point de Galle is placed  $7^{\circ} 22' 30''$  E. of Bombay. Now, allowing Bombay to be in  $72^{\circ} 54' 43''$ , as deduced in my former paper, the longitude of Point de Galle will be  $80^{\circ} 17' 13''$  east.

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Captain HUDDART, and at Calcutta,\* which gave the difference of longitude of those places  $24^{\circ} 54'$ .

Longitude of Calcutta, by the deduction in my

former Paper	.	.	.	.	88° 23' 39"
D. longitude to Canton	.	.	.	.	24 54 0
Longitude of Canton	.	.	.	.	<hr/> 113 17 39 <hr/>

Captain HUDDART, by seven eclipses of the satellites, the difference in the Tables being allowed for, made the longitude of Canton  $113^{\circ} 19' 7''$ ; the mean of both is  $113^{\circ} 18' 23''$  east of Greenwich.

J. GOLDINGHAM.

\* This information was given me at the time by Mr. J. LINDLEY, formerly Assistant at the Royal Observatory.